

WHAT IS CLAIMED IS:

1 1. A coordinated brake control system for a hybrid
2 brake system of a vehicle, comprising:
3 a vehicle operating condition detector detecting a
4 vehicle operating condition of the vehicle;
5 a first brake generating a first braking torque
6 according to a first braking torque command value;
7 a second brake generating a second braking torque
8 according to a second braking torque command value, a
9 control responsibility of the first brake being higher
10 than a control responsibility of the second braking
11 torque; and
12 a controller connected to the vehicle operating
13 condition detector, the first brake and the second brake,
14 the controller being arranged,
15 to determine a total braking torque command value
16 according to the vehicle operating condition,
17 to distribute the total braking torque command value
18 into the first braking torque command value and the
19 second braking torque command value,
20 to estimate the second braking torque,
21 to calculate a reference model response value
22 relative to the second braking torque command value on
23 the basis of a braking torque reference model which is
24 determined upon taking account of a delay of the second
25 braking torque relative to the second braking torque
26 command value, and
27 to correct the first braking torque command value
28 according to a braking torque difference between the
29 estimated second braking torque and the reference model
30 response value.

1 2. The coordinated brake control system as claimed in
2 claim 1, wherein the first braking torque command value is
3 corrected by a response delay quantity relative to the
4 braking torque command value in such a manner as to execute
5 a phase advance compensation of the braking torque
6 difference when the first braking torque command value is
7 corrected according to the braking torque difference.

1 3. The coordinated brake control system as claimed in
2 claim 1, wherein the controller is further arranged to
3 determine the total braking torque command value by
4 executing a deceleration feedback control so as to bring an
5 actual deceleration to a target deceleration according to
6 the vehicle operating condition, and to correct the first
7 braking torque command value using only a high-frequency
8 component of the braking torque difference as the braking
9 torque difference.

1 4. The coordinated brake control system as claimed in
2 claim 1, wherein the controller is further arranged to
3 determine the first braking torque command value by
4 limiting within a limited value obtained by subtracting a
5 predetermined quantity from an allowable (generable)
6 maximum braking torque when the controller distributes the
7 total braking torque command value into the first braking
8 torque command value and the second braking torque command
9 value.

1 5. The coordinated brake control system as claimed in
2 claim 1, wherein the first brake includes a regenerative
3 brake apparatus, and the second brake includes a friction
4 type brake apparatus.

1 6. The coordinated brake control system as claimed in
2 claim 1, wherein the second brake includes a hydraulic
3 brake apparatus having a brake generating the second
4 braking force according to a wheel cylinder hydraulic
5 pressure, the braking torque reference model being employed
6 when the wheel cylinder hydraulic pressure is feedback
7 controlled.

1 7. The coordinated brake control system as claimed in
2 claimed 1, wherein the controller is connected to the first
3 brake through a motor torque controller and to the second
4 brake through a hydraulic brake controller.

1 8. The coordinated brake control system as claimed in
2 claimed 7, wherein a time constant of a response
3 characteristic in the first brake is processed in the motor
4 torque controller so as to be brought to a time constant in
5 a reference model of the second brake.

1 9. The coordinated brake control system as claimed in
2 claim 1, wherein the first brake includes a hydraulic brake
3 apparatus adapted to four wheels of the vehicle, the first
4 braking torque being controlled by controlling a wheel
5 cylinder hydraulic pressure applied to the hydraulic brake
6 apparatus, the reference model response value corresponding
7 to a difference between the wheel cylinder hydraulic
8 pressure and a response value of a wheel cylinder hydraulic
9 pressure reference model.

1 10. A coordinated brake control system comprising:

2 vehicle operating condition detecting means for
3 detecting a vehicle operating condition of a vehicle;
4 first braking means for generating a first braking
5 torque actual value according to a first braking torque
6 command value;
7 second braking means for generating a second braking
8 torque actual value according to a second braking torque
9 command value, second braking torque;
10 total braking force calculating means for determining
11 a total braking torque command value according to the
12 vehicle operating condition;
13 braking torque distributing means for distributing the
14 total braking torque command value into the first braking
15 torque command value and the second braking torque command
16 value;
17 actual braking force estimating means for estimating
18 an estimated second braking torque actual value of the
19 second brake;
20 reference model response calculating means for
21 calculating a reference model response value relative to
22 the second braking torque command value on the basis of the
23 braking torque reference model which is determined upon
24 taking account of a delay of the second braking torque
25 actual value relative to the second braking torque command
26 value; and
27 command braking force correcting means for correcting
28 the first braking torque command value according to a
29 braking torque difference between the estimated second
30 braking torque actual value and the reference model
31 response value.

1 11. A method of controlling a hybrid brake system of a
2 vehicle, the hybrid brake comprising a first brake and a
3 second brake whose control responsibility is not higher
4 than a control responsibility of the first brake, the
5 method comprising:

6 detecting a vehicle operating condition of the
7 vehicle;

8 determining a total braking torque command value
9 according to the vehicle operating condition;

10 distributing the total braking torque command value
11 into a first braking torque command value according which
12 the first brake generates a first braking torque and a
13 second braking torque command value according which the
14 second brake generates a second braking torque;

15 estimating the second braking torque;

16 calculating a reference model response value relative
17 to the second braking torque command value on the basis of
18 a braking torque reference model which is determined upon
19 taking account of a delay of the second braking torque
20 relative to the second braking torque command value; and

21 correcting the first braking torque command value
22 according to a braking torque difference between the
23 estimated second braking torque and the reference model
24 response value.